THE DETROIT WATER WORKS[1]

By Theodore Alfred Leisen

The growth of any public utility usually parallels the history of the municipality which it serves, and in conformity with this axiomatic fact the development of the Detroit water supply system has kept steady pace with the varying stages of growth of the city, until at the present time the effort to maintain this pace is evolving a tendency to break all records and, figuratively, to exceed all normally established speed laws.

Historical. The water works of Detroit are of comparatively recent origin, their history dating back only to 1825, when, by virtue of a grant of the common council, certain citizens were accorded the exclusive right to supply water to the 1,500 inhabitants which then constituted the city's population. Two small pumps were placed at the foot of Randolph Street, from which place wooden pump logs, of $4\frac{1}{2}$ inches internal diameter, were extended to Randolph and Jefferson Avenue, where a 9,600-gallon wooden tank was erected as a storage reservoir. The development of this embryo plant for several years was not remarkably rapid although some evidence of growth was manifest. In 1831 the concessionaires were incorporated as the Detroit Hydraulic Company, and an added impetus was imparted to the extension of the plant by the construction of a 120,000-gallon reservoir, the erection of a new pumping station, the installation of a 20-horse-power pumping engine, and a gradual but limited extension of tamarack water mains.

The control of the works remained in the hands of this company for five years, and during this time the venture proved a financial burden instead of a source of profit. The management was subjected to continual public criticism both on account of the quality of the water and the inadequacy of the supply. The culmination of this criticism was the appointment by the common council in 1836 of a special committee of investigation, whose report declared that the company had forfeited all of the rights and privileges

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granted it under its charter, and recommended the purchase of the water works by the city. The recommendation was formally confirmed, and on June 4, 1836, the city acquired the plant for $20,500. The management of the newly acquired water works was vested in a committee of the common council, but municipal ownership did not eliminate the adverse criticism, and intermittent agitation on the part of the citizens resulted in the appointment in 1852 of a board of trustees, followed in 1853 by an act of the legislature creating the board of water commissioners, since which time the management of the water works has been under its complete charge.

Passing over the various periods of development and changes, and the abandonment through obsolescence of many of the earlier portions of the works, the actual incipience of the present plant may be said to date from 1873–74, when the property now known as Water Works Park was purchased, and construction commenced on several of the features designed to constitute the basis of the present works, including the sedimentation basin, the original pumping station; the first 24,000,000-gallon compound beam engine, and the first 42-inch cast iron main. Rapid increases in the equipment of engines and boilers, of intake pipes and tunnel, and of extensions of the main arteries to the distribution system came, with each succeeding year, as a natural sequence to the steady growth of the city, until today there exists a plant, which, if only the legitimate use of water were strictly observed, would suffice for a city of over a million inhabitants.

Statistical. The water works, as completed to date, are equipped in all of their ramifications to furnish an average daily supply of over 160,000,000 gallons, and a maximum of over 200,000,000 gallons per day, and distribute it to and beyond the extreme boundaries of the city as constituted a year ago.

The pumping equipment consists of three compound beam engines and seven vertical triple expansion engines, of capacities from 24,000,000 to 30,000,000 gallons each, and a combined pumpage capacity of 260,000,000 gallons daily. The boiler plant furnishing steam to the pumping engines consists of fifteen units of from 225 to 400 horse power each, or a total of 4400 boiler horse power, a capacity ample for the simultaneous operation of all the pumping engines with a safe marginal reserve.

The distribution system comprises 1040 miles of mains from 4 to 48 inches in diameter, of which about 100 miles are from 12 to

36 inches, and 50 miles are 42 and 48 inches in diameter. The service connections number 140,000, and represent a total length of approximately 800 miles, making a combined length of pipeage from the pumps to the consumer of 1840 miles. Embraced within the distribution system, exclusive of service connections, are 12,000 gate valves and 850 blow-off valves, and there are 7064 fire hydrants and 517 fire cisterns.

Operation. The city has been divided into low and high pressure districts. The low-pressure district embraces all territory below a contour line approximately 40 feet above the level of the Detroit River, and the high pressure district everything between the 40 and the 60-foot contours. The pressures maintained at the pumping stations average 47 pounds for the low service and 65 pounds for the high service, resulting in an average pressure of about 30 pounds at the ultimate points of distribution at normal stages.

The water supply is taken in at an intake crib in the Detroit River near the upper end of Belle Isle, 3200 feet south-eastwardly from Water Works Park, and flows thence through a 10-foot diameter brick tunnel to the shore shaft, whence it is distributed either into the settling basin, or through the by-pass conduits into the various conduits leading to the water galleries of the pumping stations.

At the shore shaft the water is treated with chlorine gas as a disinfectant, in proportions of from 1½ to 2½ pounds of liquid chlorine to a million gallons of water, or in the ratio of from 0.2 to 0.3 part of chlorine to 1,000,000 parts of water. The result of the disinfecting treatment has been the reduction of bacteria from an average of 187 per cubic centimeter in the river water to 14 in the treated effluent, and a reduction of 86 per cent in B. coli.

After the chlorine treatment the water flows normally through the so-called settling basin to the several conduits, and through four screen houses, with wire screens of ½-inch mesh, and thence to the water galleries and suction pipes of the pumps. Thence the water is forced by the pumps through four 48-inch and five 42-inch mains into all of the branches of the distribution system.

The total quantity of water pumped during the past year, as indicated by Venturi meters on the force mains, was 46,689,000,000 gallons, equivalent to an average of 127,565,000 gallons per diem, with hourly rates of pumpage varying from a minimum equivalent of 72,000,000 to a maximum of over 200,000,000 gallons per diem.

The per capita consumption, based on a carefully estimated population of 781,133 for Detroit and the suburbs supplied, was 163 gallons, a quantity largely in excess of what is adequate for all legitimate purposes according to most reliable statistics. In an effort to curtail unnecessary waste all new services are metered and old connections are being metered as rapidly as possible. There are at present 60,000 metered services, or 43 per cent of the total, and as this percentage increases, the per capita consumption should be proportionately reduced, with a consequent saving both in cost of operation and in expense for new equipment.

Recent and future improvements. During the past two years the energies of the water department have been directed principally towards the extension of the distribution system, and special efforts made to extend the large supply mains with a view to affording an increased volume of water in sections of the city remote from the pumping station, and in localities where the consumption was greatest, with a resultant stabilization of the pressures. Since July, 1914, approximately 130 miles of water mains of all sizes have been laid, including over 16 miles of mains 42 and 48 inches in diameter, and the plans for the current year contemplate a further extension of over 13 miles of 42 and 48 inch mains in addition to about 80 miles of laterals 6 to 24 inches in diameter.

The result of the addition of these large arteries to the distribution system has been a decrease in the velocity through the pipes, with a corresponding lessening of the tendency of breakage in the large mains which previously may have been caused by water hammer aggravated in its action by the excessive momentum of abnormally high velocities. The construction of the large lines in the form of loops was, it is believed, a further factor in removing the tendency to sudden shock, by creating a more evenly balanced condition of flow.

The principal single extension planned for 1917 is a new distributing main 48 inches in diameter and 10 miles long, from the pumping station to a point where it will connect with other large mains and extend thence in gradually diminishing sizes. This will make 10 force mains radiating from the pumping station, five 42 inches and five 48 inches in diameter, whose combined capacity at safe normal velocities would be upwards of 300,000,000 gallons in twenty-four hours.

The new pumping station completed two years ago was designed

to house six 30,000,000-gallon triple-expansion pumping engines, and coincident with its construction, three 30,000,000-gallon pumps were installed. The old station contained seven engines having a combined capacity of 170,000,000 gallons, and the 90,000,000 gallons of the three new pumps brought the total pumpage capacity to 260,000,000 gallons.

In January, 1917, a contract was made for two new pumping engines of the same general type as those previously installed in the new station, but designed to pump 37,000,000 gallons each at normal speed, and 40,000,000 gallons at 22 revolutions per minute, under a guarantee of 190,000,000 foot-pounds duty per 1000 pounds of steam. The first pump is to be ready for service by January, 1918. The completion of these two engines will give an available pumpage capacity of 334,000,000 gallons, or with two units out of commission for repairs or other causes, a dependable capacity of 270,000,000 gallons daily.

Plans are now being prepared for a new boiler house to be erected at the rear of the new station, which ultimately will contain six 600 horse power boilers equipped with superheaters and automatic stokers, and all other modern appliances designed to assist in scientific and economical operation. The building will be in architectural consonance with the New Pumping Station, to which it will be attached by a connecting wing containing office rooms, shower baths, toilets and locker rooms.

Overhead coal bunkers holding ten days' supply of coal will enable the stokers to be fed with a minimum of manual labor, and steam ash ejectors will remove the ashes to a conveinently located bin, from which they can be loaded directly into cars or wagons. A brick stack 12 feet in internal diameter and 250 feet in height will provide ample draft for all the boilers when operating at over rating.

Filtration. The quality of the Detroit water supply is remarkably good for a surface supply obtained from a source contiguous to a thickly inhabited section, but it is not all that might be desired from a standard of purity, and in consequence the question of filtration is one which for some years has agitated the minds of those who were intelligently interested in devising means to improve the quality of the supply. The chlorination treatment, while highly desirable in the absence of a better method, should only be considered in the nature of a temporary expedient, and performs no function in reducing turbidity or removal of organic matter from the water.

The typhoid death rate, approximating 12 per 100,000 of population, as recorded for the past few years, cannot consistently be offered as the basis for a hysterical arraignment of the character of the drinking water; but the reduction of typhoid fever is only one of several reasons, sanitary and aesthetic, which can be advanced in favor of filtration. The fact that the water supply in its present condition is not entirely satisfactory, is subject to constant criticism, and is open to the possibility of occasional serious pollution, imperatively demands that it be improved. As filtration is admittedly recognized by all who are conversant with the subject as the most efficient method of treating a public water supply, and in conjunction with partial or limited sterilization can be relied upon to convert the river water into a perfectly clear, wholesome, pure article, every dictate of reason seems to call for filtration. Carried to its ultimate analyses, the problem resolves itself into these questions: Are the citizens of Detroit satisfied to accept an inferior article in the water furnished them, or will they demand the best that can be procured, and, will a cost of less than $\frac{1}{2}$ cent per thousand gallons, the maximum cost of filtration, exclusive of interest and depreciation, deter them from exacting their demands?

Imbued with the conviction that the water supply should be purified, two propositions have been authorized which should prepare the way to a definite solution of the question of approximate cost both of construction and operation, before final steps are taken to install a filter plant for Detroit; the construction of a small experimental filter and the preparation of plans to show the proposed layout of a complete plant.

The experimental filter, which is practically complete, consists of a coagulating basin with a capacity of 18,000 gallons, and two small filter beds, each capable of filtering from 60,000 to 80,000 gallons per day. The principal object of this model is to demonstrate the maximum rate at which the water of the Detroit River can be filtered, the minimum quantity of coagulant necessary, and the requisite period of coagulation, to produce the desired results. With fairly complete records of results attained with waters of high turbidities and excessive bacterial content, it is reasonable to assume that equally satisfactory results may be secured with the comparatively clear and pure water of Detroit River, at a much higher rate of filtration, which will mean a considerable saving in the area of the filters, with a proportionate saving in cost of con-

struction, and the same principle may apply in the use of coagulants, with like results in operating costs.

The tentative plans for the filter plant provide for a low-lift pumping station; a coagulating basin with its necessary mixing chambers; a filter house having 80 filter beds; a chemical house for storing and mixing the coagulant, and a filtered water reservoir. The filtered water reservoir will occupy the space of the present settling basin, but the remainder of the plant will be located at the rear of the New Pumping Station. With the exception of the filtered water basin, all of the plant will be under one roof, but of varying elevations to conform to the requirements of the different units. The low-lift pumping station will be equipped with steam turbine driven centrifugal pumps capable of raising 400,000,000 gallons from the intake level to the coagulating basin. Steam for the turbines will be taken from the boilers in the new boiler house, and the raw water supply will be received through a 12 foot diameter conduit connected both to the 10-foot tunnel and the 6-foot conduit which parallel the easterly side of the settling basin. A screen house with motor-operated revolving screens will intercept floating ice and other coarse material in the water, before it reaches the suction well.

The coagulating basin and mixing chambers will occupy a space 400 feet wide, and 800 to 1000 feet long and have a capacity of 40,000,000 to 50,000,000 gallons, providing for a four-hour period of coagulation for 300,000,000 gallons daily. The basin will be of concrete, and provided with necessary baffles and division walls for adjusting the period of coagulation. The filter proper will consist of eighty beds of about 1200 square feet each, arranged in eight tiers of 10 beds with pipe galleries between tiers, the whole covering a space 300 by 400 feet. The full equipment of filter beds will not be required at the start, and probably 20 beds will be left for future development as the increasing consumption may demand. The chemical house will be placed between the coagulating basin and the filters, rising to a higher elevation for the storage and mixing space, and will be surmounted centrally by the wash-water tower.

The filtered water basin will be 350 feet wide, 800 feet long, and 20 feet deep, giving a capacity of 40,000,000 gallons. It will be all concrete construction, covered and parked over the top and laid out in tennis courts or ornamental shrubbery and lawn.

The plans in all their features contemplate a daily capacity of

over 300,000,000 gallons, with provision for meeting peak loads of 10 per cent. above the maximum normal conditions. It is difficult to predict what the future will require, but when the average daily consumption approaches 300,000,000 gallons, a second station located farther up the lake and equipped with large centrifugal units will probably be the solution.